Insect Mating Disruption – An Alternative Pest Management Strategy for Long Island Tree Fruit Orchards

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Pest management is a vital part of tree fruit production on Long Island, NY, where pesticides are used for the control of various pests including oriental fruit moth (OFM) and codling moth (CM). Analysis of recent (2012–2013) pesticide application records in tree fruit orchards reveals most insecticide applications were driven by these two insects. Improperly used pesticides are of great concern, for Long Island's sole-source underground aquifer (over 3 million people depend on it), the L.I. Sound and the Peconic Estuary, and growers face other pressures to minimize use of pesticides in a highly populated region. According to the 2013 NY State Department of Environmental Conservation's Long Island Pesticide Pollution Prevention Strategy (now called L.I. Pollution Prevention Strategy) (http://www.dec.ny.gov/chemical/87125.html) Report: "Water quality monitoring by Suffolk County and other entities shows that pesticides are among a number of contaminants detected in Long Island groundwater as a result of a wide range of human activities". A 2011 NYS DEC study shows that shallow private wells in agricultural areas are vulnerable to pesticide contamination, with more than 50% of the samples taken from these wells containing detectable pesticide residues. L.I. fruit growers are also facing issues different from other fruit growing areas of the State. The majority of L.I. tree fruit production is marketed locally as U-pick (pick-your-own) or from farm stands for fresh consumption, as part of the growing interest in agro-tourism on eastern Long Island, which attracts over 1.2 million tourists each year from the metropolitan area. Although pesticides are generally not applied at or close to harvest, growers note that consumers frequently express concerns about pesticide use on produce.

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Although not documented on Long Island, CM and OFM can develop resistance to organophosphate, carbamate and pyrethroid insecticides. Due to groundwater concerns, some newer pesticides are restricted from use on L.I. These issues have elevated interest in alternative management methods, including insect mating disruption (MD). The technology uses synthetically produced sex pheromone dispensers placed out in the orchard, to release a "cloud" of pheromone that prevents males from orienting to a particular female. Unmated females fail to reproduce; over time, the pest population and crop damage decrease, often to negligible levels.

Used in other states and regions of NY (Joshi 2008; Agnello 2009; Breth 2010), MD had been used only minimally in L.I. orchards until around 2013, when Lea Loizos, Technician with the Cornell Cooperative Extension of Suffolk County Agriculture Stewardship Program, began working with growers to expand IPM practices. In 2014, we initiated a 3-year participatory project to increase adoption of IPM in Long Island tree fruit orchards. The project engaged 10 growers in using non-insecticidal area-wide insect mating disruption for CM and OFM control in orchards by providing a 40% cost offset for pheromone dispensers, to encourage adoption of the proven technology. The program also included added support to assure growers the strategy was performing as expected, as well as in-season and at-harvest fruit quality evaluations to provide added feedback.

Methods

Grower participation: As participating partners, L.I. fruit growers agreed to include MD techniques initially on a trial ba-

Figure 1. Aerial view shows the position of participating tree fruit orchards on Long Island, NY.

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sis, replacing the traditional insecticide-based management approach, despite the higher cost and perceived risk associated with new technology. Most L.I. orchards are mixed blocks of pome and stone fruits. Long Island has approximately 360 productive tree fruit acres, located mostly in eastern Suffolk Co., including 28 acres of new plantings since 2014 (Figure 1). About 288 (78% of the total acreage) are suitable for using MD. Insect populations are typically uneven across the landscape. Approximately 10% of the total acreage (about 33 acres) didn't have significant OFM/CM infestations before 2014, and CM in particular was uncommon. Another 12% (about 40 acres) was not suitable for MD because of small planting size or fragmented shape. While we provided suggestions on target pests for each site, the project allowed growers to make their own decision about which MD product to use. Participating growers chose Isomate ties (CM/OFM-TT and OFM-TT) for codling moth and/or oriental fruit moth control in pome and stone fruits. Six growers, who own about 233 acres total, decided to use MD during the 2014–2016 seasons. Each year in late winter to early spring, the project investigators met individually with participating tree fruit growers to discuss pest management priorities for each block, details of the MD strategy, weekly monitoring by project staff, and other regular support the program would be providing throughout the season. Aspects covered included pheromone tie placement, durability, availability, verifying performance, and actual costs of the program for each orchard block. Four growers, who own about 70 acres total, decided not to use MD. These four orchards were included in the project for comparing outcomes between MD and non-MD approaches. Weekly trap data were provided to non-MD growers, and these orchards were managed under traditional insecticide based control.

Deploying pheromone dispensers: Orchard sizes of participating farms varied between 5–62 acres. A workshop on MD was organized by the project investigators to educate and train growers and workers on using MD in orchards, and a handout on MD describing the technique and illustrating proper use was distributed and also published in Suffolk County Agricultural News, reaching 300 subscribers, including fruit growers. Project staff worked with each grower to determine the appropriate amount of product needed for each block. Isomate CM/OFM-TT was used at 150-200 ties/A and Isomate OFM-TT was used at 100 ties/A. With on-site assistance from project staff, pheromone ties were deployed in trees during bloom for apples and at fruit set for peaches (Figure 2). To help growers with proper deployment, project staff met with workers at each site to demonstrate placement, and then followed up during mid-May to mid-June, to make sure ties were correctly located and distributed.

Figure 2. Placment of Isomate TT mating disruption ties on the top section of the tall trees with an expandable hoop applicator. (Photo: Pacific Biocontrol)

Performance check: Each season from May to September, over 60 monitoring traps (40 OFM, 20 CM) were set in project orchards and checked weekly to ensure the effectiveness of mating disruption. Traps were set in both MD and non-MD orchards to compare moth populations in both situations. CM L2 and OFM L2 lures (long-life standard lures) were used in traps hung 5 feet above ground. Weekly monitoring data were provided to the growers to help growers track insect population status in their orchards, as well as to assess whether MD was working properly. During the growing season, project investigators also made frequent visits to the participating orchards to conduct random fruit checks for signs of insect infestation or injury (Figure 3). Growers were also provided necessary recommendations, such as information on other insects not controlled by MD (such as plum curculio and European apple sawfly), reduced-risk insecticide options, and other periodical scouting data.

Figure 3. CCESC Agricultural Stewardship technicians shown scouting fruits. (Photo: Faruque Zaman)

Insecticide applications: Insecticides for CM and OFM were applied in the MD orchards only if the trap catches were above the designated threshold (2 or more for CM, and 5 or more OFM per week). Orchards not using MD had a 1st insecticide application recommended according to the Michigan State University model (Rothwell 2013) at 200–250 degree-days (50°F) after biofix (first moth catch) for first generation, with a 2nd application 10–14 days later; then, successive treatments for the second generation were based on an action threshold of 5 and 15 moths trapped/week, respectively, for CM and OFM. L.I. growers are mostly limited to Assail and Delegate insecticides (Coragen, Altacor, Belt, Calypso, and Intrepid, are not approved for use on L.I.), with Assail preferred for 1st generation egg hatch targeting CM, OFM, and incidental control of European apple sawfly and plum curculio. Delegate was suggested for mid-season control targeting CM, OFM, and incidental control of leafrollers. Other pests such as European red mite, apple maggot, and aphids, were controlled as needed using reduced-risk or low environmental impact products where possible.

Figure 4. Blemish-free apples ready to harvest protected by mating disruption ties. (Photo: Faruque Zaman)

Pre-harvest evaluation: Prior to fruit harvest, an average of 18,000 apples and 4,000 peaches per year were visually inspected for insect-related fruit damage both in MD and non-MD orchards (Figure 4). A total of 500 fruits per sample were randomly checked from 10 interior and 10 border trees. Number of samples per orchard varied between 2 to 7 based on block size.

Results and Outcomes

Mating disruption use: During 2014–2016, the project implemented MD in 70% (233 acres) of L.I. tree fruit acreage, about 3.5 times the acreage under MD prior to the project in 2013 (<20% of total acreage).

Pest monitoring: Knowing the pest status and population trends are keys for a successful pest management operation in any agriculture production. Production of high quality fruit and economic sustainability of orchards largely depend on timely control. Over the project period, CM populations were noticeably lower in MD orchards, compared with orchards not using MD (Figure 5). An average of 1.08, 0.20, and 0.07 CM/trap/week were captured from the MD blocks compared with 2.47, 1.75, and 2.40 CM/trap/week from the non-MD blocks in 2014, 2015, and 2016, respectively (Table 1). Based on trap data, we saw a clear trend of decreasing CM populations in the MD area, but a steadily increasing population was found in non-MD orchards. A similar trend was found in the OFM populations. In 2014, the season began with a high OFM flight (as high as 60 moths/trap/week) in some orchards, but populations in MD orchards dropped to far below economically damaging levels in 2015 and 2016 (Figure 6). An average of 1.52, 0.21, and 0.28 OFM/trap/week were captured from the MD blocks, compared with 3.08, 1.37, and 1.83 OFM/trap/week from the non-MD blocks in 2014, 2015, and 2016, respectively (Table 1).

Table 1. Average numbers of codling moths and oriental fruit moths/trap/week in mating disruption and non-mating disruption orchards in 2014–2016. Numbers in parentheses are the number of traps checked each season.

	Codling moth			Oriental fruit moth		
Pest management used	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
Mating disruption	1.08 (8)	0.20 (9)	0.07 (9)	1.52 (25)	0.21 (19)	0.28 (20)
Non-mating disruption	2.47 (10)	1.75 (11)	2.40 (11)	3.08 (16)	1.37 (16)	1.83 (16)

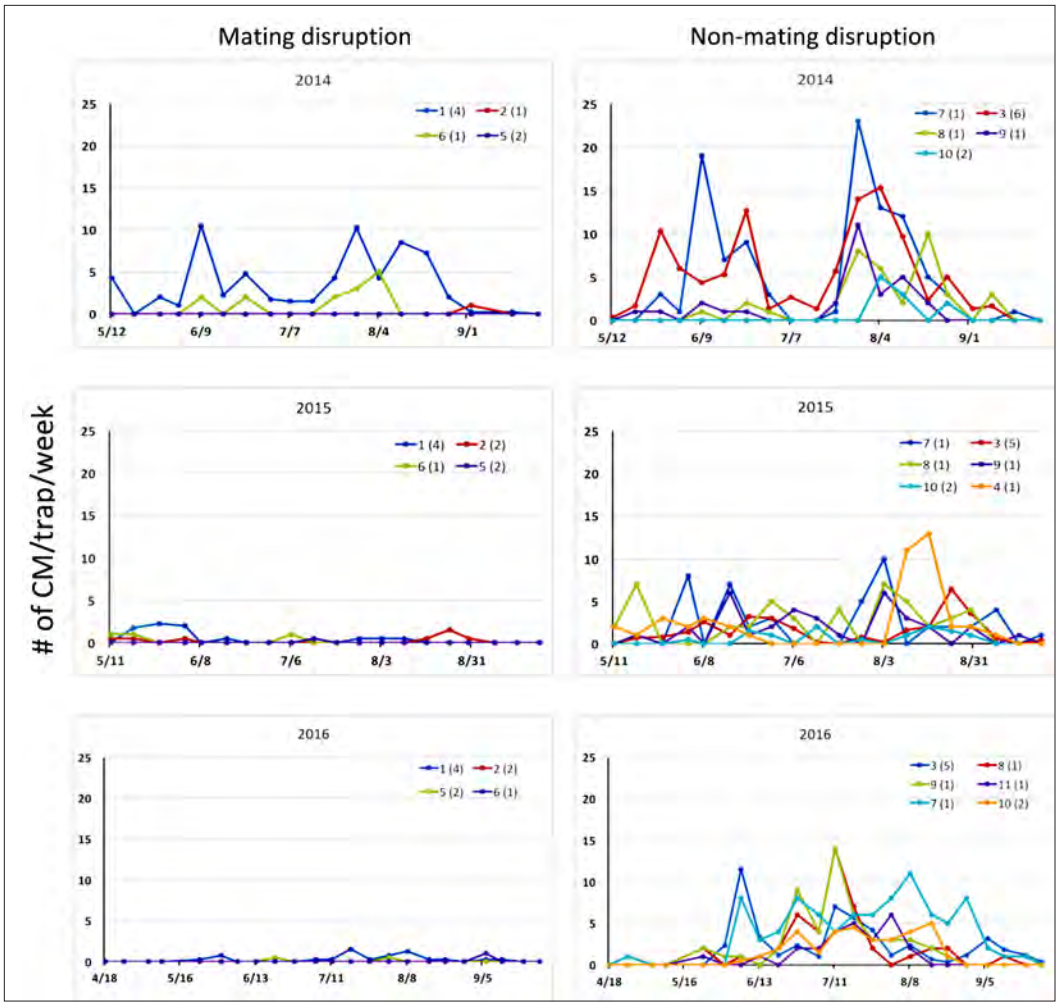

Figure 5. Weekly codling moth trap captures using CM L2 lures in mating disruption (L) and non-mating disruption (R) tree fruit orchards on Long Island from 2014–2016. Number in parentheses are the number of traps checked each season.

Fruit damage evaluation: Codling moth, plum curculio, tarnished plant bug, European apple sawfly, oriental fruit moth, and stink bug were the most significant insect pests in pome and stone fruits on L.I. during the project period. On average, these insects were responsible for 5.0% of apple and 1.25% of peach damage. Over the past three years, while CM damage to apples was less than 0.5% in MD areas, up to 23% CM fruit damage was found (Figure 7) in one orchard where mating disruption was not used or properly executed. OFM damage was very low, just 0.25% in apples and 0.15% in peaches, in the MD area. However, in the non-MD blocks, nearly 2.0% fruit was found damaged by OFM.

Economic viability: From 2014-2016, growers using MD spent approximately $133–$259 per acre for CM and OFM control in apples and $81–207 for OFM control in peaches. This is based on current prices for MD dispensers (Isomate CM/OFM-TT and OFM-TT) plus 2 applications of either Assail or Delegate. Prior to the project, some non-MD orchards used up to 6–8 applications of insecticide per season (data collected from pre-project period application records) costing $379–$506 per acre (rotating application of Assail and Delegate). Although some orchards reduced costs by using organophosphate, pyrethroid or other products, efficacy of these products were not as expected. For orchards using MD, insecticide applications generally remained at around 0–2 per season for CM and OFM. We estimate growers saved about $212–$247 per year in pest management costs. For growers with already low CM and OFM populations, we feel the cost of using MD will compare favorably to existing pesticide expense, although there may be need for occasional supplemental insecticide applications. This additional cost can be reduced by regular monitoring and site-specific applications. Given the current CM and OFM population trend in L.I. non-MD orchards (Figures 5 & 6), we expect at least 4 insecticide applications per season will be needed in these blocks, which compares favorably to the cost of MD plus 2 insecticide applications (assuming blocks of sufficient size for MD use). All costs were calculated based on retail product prices. Labor, fuel or other associated application costs were not included, but would increase costs, especially for insecticide application.

Impacts and beneficiaries: Under the cost-sharing agreement, project fruit growers were provided 40% reimbursement of the mating disruption tie purchase costs to offset the additional expenditure of trialing MD. Cost-sharing support has motivated and encouraged growers to incorporate MD as a standard practice beyond the project period. We feel that growers, orchard workers, consumers, and the environment all benefit from use of this technology through reduction in unnecessary insecticide use. The program has also promoted adoption of reduced-risk insecticides over older more broad-spectrum products: currently 75% of insecticides used in L.I. fruit orchards are EPA-designated reduced-risk

Figure 6. Weekly oriental fruit moth trap capture using OFM L2 lures in mating disruption (L) and non-mating disruption (R) tree fruit orchards on Long Island from 2014–2016. Number in parentheses are the number of traps checked each season.

Figure 7. Severe infestation from codling moth in a non-mating disruption orchard on Long Island 2015. (Photo by Faruque Zaman).

materials. L.I. agriculture, and orchards in particular, are important to the local economy and an increasing attraction for tourism.

Conclusions

Pesticide application timing and the choice of materials are the most critical issues for L.I. tree fruit growers because of mixed-cultivar blocks, variable harvest periods, the demand for high quality fruit, tourist-centered marketing, and restrictions on product use. The mating disruption technology is highly appropriate for L.I. growers, but also benefits from a strong support system to assist implementation. This project has increased MD use in L.I. orchards from less than 20% to over 70% of total acreage within the last three years. The project was also successful in reducing CM and OFM populations in some orchards to far below economic threshold levels, with fruit damage at a minimum. While the early season investment for MD ties may seem initially high, the overall seasonal costs for CM and OFM control favorably compares to solely insecticide-based management. In some cases, use of MD is much less expensive, depending on pest pressure and history of insecticide use. We believe with mating disruption alone (for orchards with low insect pressure) or in combination with effective insecticides and timely applications (for orchards with moderate to high insect pressure), fruit damage can be significantly reduced and maintained at a low level. The long term use of MD with careful monitoring can help maintain target insect populations in the orchard at low levels. With MD, regular monitoring is vital for timely decision making and determining strategic pest control applications. Based on our current fruit damage assessments (very low CM/OFM-related fruit damage in MD orchards; see Table 2) in MD and non-MD orchards, it was difficult to measure the economic value of using MD or a combination of MD and insecticides in all orchards, but we expect MD to minimize risk of developing resistant populations in orchards. Marketing decisions (as fresh fruit, in cider, or processed in other ways) may also influence use of MD and tolerance for fruit damage.

Table 2. Percent codling moth and oriental fruit moth damage in apples (CM and OFM) and peaches (OFM only) in mating disruption and non-mating disruption orchards on Long Island, 2014–2016.

Farm ID	MD use		# fruit checked	% damage by CM/OFM	
	Pome	Stone		Apple	Peach
2014					
1	yes	yes	3000	0.27	0.00
2	yes	yes	1500	0.00	…
3	no	no	4500	8.41	0.20
4	…	yes	2000	…	0.00
5	yes	yes	5000	0.00	0.40
6	yes	yes	1000	0.25	0.00
7	no	…	…	…	…
8	no	…	1500	0.00	…
9	no	…	1500	0.00	…
10	no	yes	3000	0.00	0.00
2015					
1	yes	yes	2000	0.65	0.20
2	yes	yes	2500	0.28	…
3	no	no	4500	22.20	0.60
4	…	yes	2000	…	0.00
5	yes	yes	4000	0.00	0.30
6	yes	yes	1000	0.70	0.00
7	no	…	1000	0.20	…
8	no	…	1000	0.20	…
9	no	…	1500	0.10	…
10	no	yes	3000	0.20	0.00
2016					
1	yes	yes	3000	0.20	0.10
2	yes	yes	4000	0.10	0.00
3	no	no	4000	6.36	0.60
4	…	yes*	2000	…	1.30
5	yes	yes	4500	0.20	0.08
6	yes	yes	1500	1.06	0.20
7	no	…	…	…	…
8	no	…	1000	0.20	…
9	no	…	1500	0.70	…
10	no	yes	3500	0.23	0.00

* - MD ties not properly placed

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Faruque Zaman is Associate Entomologist at CCESC responsible for tree fruit pest management on Long Island. **Laurie McBride** is former Agricultural Stewardship Technician of CCESC who was involved in the day-to-day activities of the project. **Shannon Moran** is an Agricultural Stewardship Technician involved with the project since 2016 and currently has field responsibilities for the fruit IPM program. **Dan Gilrein** is an Extension Entomologist with Cornell Cooperative Extension of Suffolk County.